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The Effects of Trade Reforms on Scale and Technical Efficiency

New Evidence from Chile

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Pressure from foreign competition forces all firms toward common, higher levels of productivity.

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This paper — a product of the Trade Policy Division, Country Economics Department — was prepared for the World Bank research project, "The Effects of Trade Regimes on Industrial Competition and Efficiency" (RPO 674-46). Copies are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Rebecca Sugui, room N10-031, extension 37951 (44 pages, including tables).

How did industrial structure and performance change after Chile's dramatic trade liberalization?

A comparison of the 1967 and 1979 censuses shows little improvement in productivity overall — but these figures don't separate the effects of trade liberalization from the effects of recession, high interest rates, and real appreciation.

To isolate the effects of trade liberalization, Tybout, de Melo, and Corbo compared industries in which protection was significantly reduced with industries in which it was not. Several findings emerged.

First, in industries for which protection was lifted, the smallest plants tended to expand output more. Cross-plant estimates of returns to scale dropped significantly. These findings are consistent with the view that exposure to foreign competition forces suboptimally small producers toward minimally efficient scale.

Second, production levels became higher and more uniform across plants in those industries undergoing dramatic reductions in protection.

Taken together, these results support the received wisdom that increased exposure to trade improves competition within an industry.

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I. OVERVIEW

For several reasons, development economists routinely argue that trade protection reduces industrial sector efficiency. First, in markets characterized by entry barriers, the absence of foreign competition allows domestic producers to enjoy monopoly power and excess profits. Consequently, these firms may fail to produce at minimum efficient scale (achieve "scale efficiency") and/or to get the maximum possible output from their input bundles (achieve "technical efficiency" or "X-efficiency"). Second, in markets characterized by Chamberlinean competition, trade protection may attract inefficiently small producers, causing similar increases in average production costs.[1] It is sometimes claimed that these two intra-industry effects of protectionism are more important sources of welfare loss than the traditional comparative advantage effects.

Disturbingly, the body of empirical evidence supporting these claims is ambiguous. For example, Rodrik (1988a) notes that "there is practically no direct evidence on the importance of scale economies in specific industrial sectors of the developing countries." Similarly, Pack (1988) observes that "to date there is no clear confirmation of the hypothesis that countries with an external orientation benefit from greater growth in technical efficiency in the component sectors of manufacturing." Finally, Bhagwati (1988) concludes "although the arguments for the success of the export promotion strategy based on economies of scale and X-

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1/ For more detail on arguments involving scale effects, entry and exit, see Roberts and Tybout (1990). For a compact review of the literature linking trade and technical efficiency in LDCs see Rodrik (1988b).

efficiency are plausible, empirical support for them is not available." One is left wondering whether the received wisdom is more a matter of faith than fact.

The lack of clear evidence is not accidental. To examine the intra-industry effects of trade reforms directly, one must make "before and after" comparisons of a large sample of plants. Sufficient data are rarely available for the appropriate countries at the appropriate times. Fortuitously, however, the Chilean trade liberalization of 1974-79 was preceded and followed by industrial censuses, providing a natural experiment. This paper is an effort to document the evidence that emerged.

The paper is divided into three remaining sections. After some background on Chilean reforms, section II presents descriptive measures of the size distribution and productivity of each industry in each census year. Changes in these measures across census years are then correlated with industry-specific changes in effective protection rates. The results are suggestive, but suffer from conceptual problems, measurement error and missing data problems. Hence section III corrects for these shortcomings and re-examines patterns of association. The results reinforce and extend the findings in section II: Although <u>overall</u> industrial efficiency did not improve between the two census years, the 3-digit industries that underwent relatively large reductions in protection improved relative to others.

II. A GLANCE AT THE DATA

A. Changes in the Chilean Economy Between The Census Years

In this section we take a first look at the data to familiarize the reader with general magnitudes and sources of variation. But before discussing descriptive statistics, it is worth reviewing the major changes that took place in Chile between the two census years.[2]

Like most developing countries, Chile pursued an import-substituting industrialization strategy in the 1950s and 1960s. By 1967 -- the first year for which we have plant-level data -- quantitative restrictions (QRs) were widespread. The cross-sectoral dispersion in tariff rates was extremely high, and the average effective protection rate for manufacturing was over 100 percent (Behrman, 1976). In addition, market entry and exit were limited by extensive controls on the domestic credit market and by labor laws that made worker dismissal difficult. Finally, price controls on domestic commodity markets were pervasive.

By 1979 -- the other year for which we observe plants -- the situation had changed dramatically. All QRs had been removed in 1974, and between 1975 and 1979, the average effective protection rate rate had been brought down below 15 percent, while cross-sectoral dis[illegible]ion in tariff rates had been virtually eliminated. Thus by 1979, Chile had achieved one of the lowest and most uniform protection structures in the world. The domestic labor and financial markets had also been deregulated and price controls on sales in the domestic market had been removed.

B. Industry-wide Changes in Structure

Table 1 summarizes the ways in which industrial structure, productivity and exposure to foreign competition changed between the two census years. Referring to the top panel, notice that the dramatic drop in protection was accompanied by clear increases in import shares, export

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2/ See Corbo (1985) for further details.

Table 1: AGGREGATE INDUSTRIAL STRUCTURE, 1967 AND 1979

	1967 (1)	1979 (2)	Ratio (2)/(1)
Market Conditions[a]			
Effective Protection	120%	15%	.13
Export Share	4%	13%	3.25
Import Penetration Rate	20%	29%	1.45
Intra-Industry Trade Index	.14	.28	2.00
Manufacturing Unemp. Rate	5%	13%	2.60
Plant Size Distribution[b]			
Average Gross Output per Plant	37,241	37,425	1.01
Number of Plants	7,060	6,771	.96
10th output percentile	1,430	1,051	.74
25th output percentile	3,006	2,358	.78
median output	[illegible],203	5,723	.79
75th output percentile	20,972	16,126	.77
90th output percentile	75,536	60,442	.80
99th output percentile	507,189	595,724	1.17
Factor Use and Productivity[b]			
Value Added per Plant	21,403	15,978	.75
Workers per Plant	39	34	.88
Efficiency Labor per Plant[c]	188	185	.98
Capital per Plant[d]	30,760	59,853	1.95

[a] All figures refer to manufacturing. Trade flow data are taken from de Melo and Urata (1986). Let X, M and Q represent exports, imports and domestic production, respectively. Then the export share is X/Q; the import penetration rate is M/(Q+M-X), and the index of intra-industry trade is $1.0 - |X-M|/(X+M)$. Effective protection figures are taken from Behrman (1976) and Aedo and Lagos (1979). We omit the glass industry in calculating mean effective protection rates because its 1967 value of 3500% was an extreme outlier. Unemployment figures come from Banco Central de Chile (1986).

[b] These figures refer to the census data after cleaning. Variables valued in 1967 prices were converted to 1979 prices.

[c] wage bill divided by the minimum wage, which is held constant in real terms across census years.

[d] figures are based on plants reporting complete capital stock data. Such plants constituted 38 percent of the sample in 1967 and 35 percent in 1979.

shares, and intra-industry trade. So trade liberalization apparently did place domestic manufacturers in more direct competition with their foreign rivals. Also, however, it combined with macro stabilization policies to create unemployment problems that still lingered in 1979.

The middle panel of table 1 describes the plant size distribution. Here notice that output per plant remained surprisingly stable between 1967 and 1979, while the number of plants fell slightly. This lack of expansion presumably reflected the same forces that created recession and unemployment during the second half of the 1970s. Notice also that, while the largest plants expanded, most others contracted. So if small plants were below minimum efficient scale in 1967, they were probably more so after the liberalization.

Measures of value-added per unit input give a crude sense for productivity levels; these can be inferred from the bottom panel of table 1. Referring to the last column, note that value-added per plant fell more rapidly than workers per plant (however measured) between 1967 and 1979, so labor productivity dropped. Similarly, for those plants reporting complete capital stock data, value-added per unit capital fell.[3] Taken together, these results suggest an unequivocal fall in total factor productivity for the manufacturing sector as a whole between 1967 and 1979. Like the low output growth, this productivity drop probably reflected the relatively slack demand for manufactured products in 1979, coupled with a gradual

3/ Bear in mind, however, that measurement problems are particularly acute for capital stocks, which are reported by only a fraction of the plants and are expressed in historic cost deflated by a general capital stock price index.

change in the mix of products and the nature of technology.[4] Measurement error is also likely, especially in capital stocks and the price deflators.[5]

C. Sector-Specific Structural Change

For several reasons, we caution against viewing the patterns of adjustment in table 1 as driven exclusively, or even mainly, by trade policy. First, as already noted, the available price indices may exhibit general biases over time, and some of the variables are measured with error. Second, and more importantly, Chile underwent many major policy changes between 1967 and 1979, including hyper inflation during 1973, a major recession during 1974-76, exchange rate appreciation thereafter, and large increases in the real interest rate. In terms of influence on manufacturing sector aggregates, these forces could easily have masked the effects of commercial policy.

Comparisons of adjustment patterns among the different three-digit industries are more likely to reveal something about the effects of trade liberalization. This is because all industries were subject to roughly the same measurement errors and changes in macro conditions, but different

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4/ Reductions in the ratio of industrial value added to industrial output are typically observed as the process of economic development unfolds. See, for example, Chenery, Syrquin, and Robinson (1986).

5/ We used official price series at the three-digit industrial clasification level from Chile's Instituto Nacional de Estadastica to deflate outputs, and combined these prices with the 1977 Chilean input-output table to impute sector-specific intermediate input price deflators. Experimentation with other price indices did not signficantly change our findings. Further details of our data preparation are available upon request.

industries underwent very different amounts of change in protection. Therefore, deviations of particular industries from the typical pattern of adjustment probably partly reflected the amount of new foreign competition that these industries faced.

To see whether changes in trade exposure correlate with changes in structure and performance, we construct a set of industry-specific variables. First, we measure the change in protection between 1967 and 1979 with:

$$PROTEC_j = (1+R_j^{79})/(1+R_j^{67}) \ .$$

where R_j^t as the effective protection rate for the j^{th} industry in year t.[6] Similarly, we construct a set of industry-specific measures of change in size, factor use, and productivity. But for these variables, we provide extra detail by looking at the shape of the entire cross-plant distribution in each year -- just as in the middle panel of table 1. For example, we measure changes in the size distribution of plants wtih the following six variables:

$$RQn_j = (1+Qn_j^{79})/(1+Qn_j^{67}), \qquad n = 10,\ 25,\ 50,\ 75,\ 90,\ 99 \ .$$

Here Qn_j^t represents the output of the plant at the n^{th} percentile during year t, given that plants in this industry and year have been sorted in order of increasing output. So if median plant size falls between the census years for industry j, $RQ50_j$ will be less than one. Also, if the shape of the size distribution changes, this will be reflected by different values for the different percentiles. We constuct analogous variables to

6/ Estimates of the effective rates of protection by industry and year are taken from Behrman (1977) and Aedo and Lagos (1986).

measure changes in value-added (RVn), employment (RLn), value-added per efficiency unit (RVEn), value-added per unit capital (RVKn), gross output per efficiency unit (RQEn), and gross output per unit capital (RQKn).[7]

We choose these variables for several reasons. First, use of the ratio form makes it possible to ignore any macro shock or data bias that affects all industries equally.[8] It also allows us to ignore industry-specific effects that do not vary over time. Second, by including both gross output and value-added in our set of variables, we can see whether the findings hinge critically on measurement problems with the latter.

Different three-digit industries presumably react differently to changes in protection. So, to avoid forcing all industries into the same mold, we use Spearman rank correlations to look for dominant patterns of association between PROTEC and the various measures of structure and performance. These correlations are reported in Table 2 for each variable and percentile, along with associated t ratios.

Several conclusions can be drawn. First, sectors with relatively large declines in protection have shown a somewhat greater tendency toward employment reductions. For example, the correlation between changes in protection and changes in the 50^{th} employment percentile is .260, indicating that reductions in protection are associated with reductions in employment among plants with no more than the median number of workers.

7/ Ratios involving capital are constructed using only the subset of plants reporting complete capital stock data.

8/ By "equally," we mean that the shock or bias scales the ratio of interest by an amount that is independent of j.

Table 2: CROSS-INDUSTRY RANK CORRELATIONS -- CHANGES IN PROTECTION WITH CHANGES IN INDUSTRIAL CHARACTERISTICS

PROTEC correlated with:	Percentiles (n) 10th	25th	50th	75th	90th	99th
Gross Output (RQn)	-.327 (1.50)	-.193 (.86)	-.062 (.26)	.157 (.69)	.133 (.59)	.108 (.47)
Value Added (RVAn)	-.481 (2.39)	-.338 (1.56)	-.251 (1.13)	-.168 (0.74)	.003 (0.01)	.054 (.23)
Employment (RLn)	.251 (1.13)	-.055 (.25)	.260 (1.17)	.520 (2.67)	.397 (1.89)	.251 (1.13)
Efficiency Labor (REn)	.075 (.33)	-.018 (.08)	.348 (1.61)	.395 (1.87)	.222 (.99)	.181 (.80)
Value Added per Efficiency Labor (RVAEn)	-.577 (3.08)	-.434 (2.10)	-.410 (1.96)	-.304 (1.39)	-.414 (1.98)	-.071 (.31)
Value Added per unit Capital (RVAKn)	-.392 (1.85)	-.246 (1.11)	-.199 (.88)	-.323 (1.48)	-.236 (1.06)	-.221 (.98)
Gross Output per unit Efficiency Labor (RQEn)	-.451 (2.20)	-.418 (2.01)	-.462 (2.27)	-.319 (1.47)	-.516 (2.63)	-.022 (.09)
Gross Output per unit Capital (RQKn)	-.218 (.96)	-.143 (.62)	-.158 (.70)	-.414 (1.98)	-.419 (2.01)	-.358 (1.67)

Absolute values of t ratios are in parentheses

This reduction is most striking among plants in the third largest quartile, and is stongest when employment is measured in terms of number of workers. Second, however, reductions in protection are associated with <u>higher</u> value added and output among the smallest plants. This effect is stongest in the lowest decile, and is nonexistent among plants above the median. So there is some evidence that, as protection falls, small plants increase production levels toward minimum efficient scale, shedding labor at the same time.[9]

Given that labor use falls and output rises as protection is reduced, it is unsurprising that value-added per efficiency worker and output per efficiency worker both rise. As with the output effects, these responses are concentrated among the smaller plants.[10] This finding supports X-efficiency arguments linking trade exposure and productivity.

Finally, and less strikingly, output per unit capital and value-added per unit capital tend to rise most in those industries where the reductions in protection were most dramatic. Hence, given that reductions in protection are associated with increases in both output per employee and output per unit capital, any standard index of total factor productivity growth constructed from these data would probably correlate negatively across industries with changes in protection.

9/ Comparing plants' employment levels in Chile (1979-1986) and Colombia (1977-1987), Roberts and Tybout (forthcoming) found that high rates of protection were associated with relatively large plants -- both in terms of output and in terms of employment -- once industry and country effects were controlled for. This finding is consistent with the present paper's findings regarding correlations of protection with workers per plant, but not with its findings regarding output per plant.

10/ Efficiency effects aside, a reduction in effective protection can cause an increase in value-added to the extent that technology allows plants to substitute away from intermediate goods usage as their relative price rises. We are grateful to Ramon Lopez for this point.

III. BETTER MEASURES OF EFFICIENCY CHANGES

All of the above is very suggestive, but it glosses over two types of measurement problems. The first is that table 2 is limited to single factor productivities. Accordingly, it does not allow us to measure overall productivity of the input bundle, or to distinguish between scale effects and X-efficiency effects. The second problem concerns data quality. Value-added and capital stock figures are likely to be biased because of inflation-distorted bookkeeping. Moreover, even without inflation, book values of capital stocks reflect historic cost rather than economic worth, and the discrepancy in values should increase as the capital ages. Finally, for many enterprises capital stock figures are missing entirely. This section presents an attempt to come to grips with all of these shortcomings.

A. Indices Of Scale and Technical Efficiency

First, by going to a parametric representation of production technologies, we can easily construct better measures of efficiency. Assume that intermediate inputs are used in fixed proportion to gross output, and let the maximum value-added attainable with given amounts of capital (K^*) and labor (E) be represented by the production function $f(K^*,E)$. Then returns to scale are simply the sum of the elasticities of f( ) with respect to its arguments. If this sum exceeds one for a given vector of inputs, the associated plant is said suffer from <u>scale inefficiency</u>. Also, if the i^{th} plant is using inputs (K^*_i,E_i) and producing value added V_i, then $e_i = f(K^*_i,E_i) - V_i$ is an index of the plant's level of technical inefficiency.[11]

Our objective is infer something about the changes in these efficiency measures that accompany trade liberalization. Ignoring econometric and data problems for the moment, imagine we are able to obtain consistent estimates of the following Cobb-Douglas production function for each industry and year:

$$(1) \qquad V = \alpha K^{*} + \beta_0 + \beta_1 E + \beta_2 D_1 + \beta_3 D_2 + \beta_4 D_3 + u_1 .$$

Here D_1 through D_3 are dummies that control for things like type of firm ownership, u_1 is a disturbance term, and all other variables are assumed to be measured in logarithms. (More detailed variable definitions are provided in the appendix.) Then inferences regarding scale and technical efficiency can be based on estimates of α, β_0, β_1, and $var(u_1)$.

To see how, refer to figure 1. Here we represent $f(K^*,E)$ indirectly with its dual, the technically efficient cost function $g(V)$. This allows us to work in two dimensions. All variables are in logarithms, so $1/g'(V)$ reflects returns to scale, and $g(\ )$ follows the usual pattern of increasing returns in low output ranges, then constant or diminishing returns. Dots and asterisks are hypothetical data points; they represent cross-sectional observations on plants in a givenindustry. All data points lie above $g(V)$ to indicate that the

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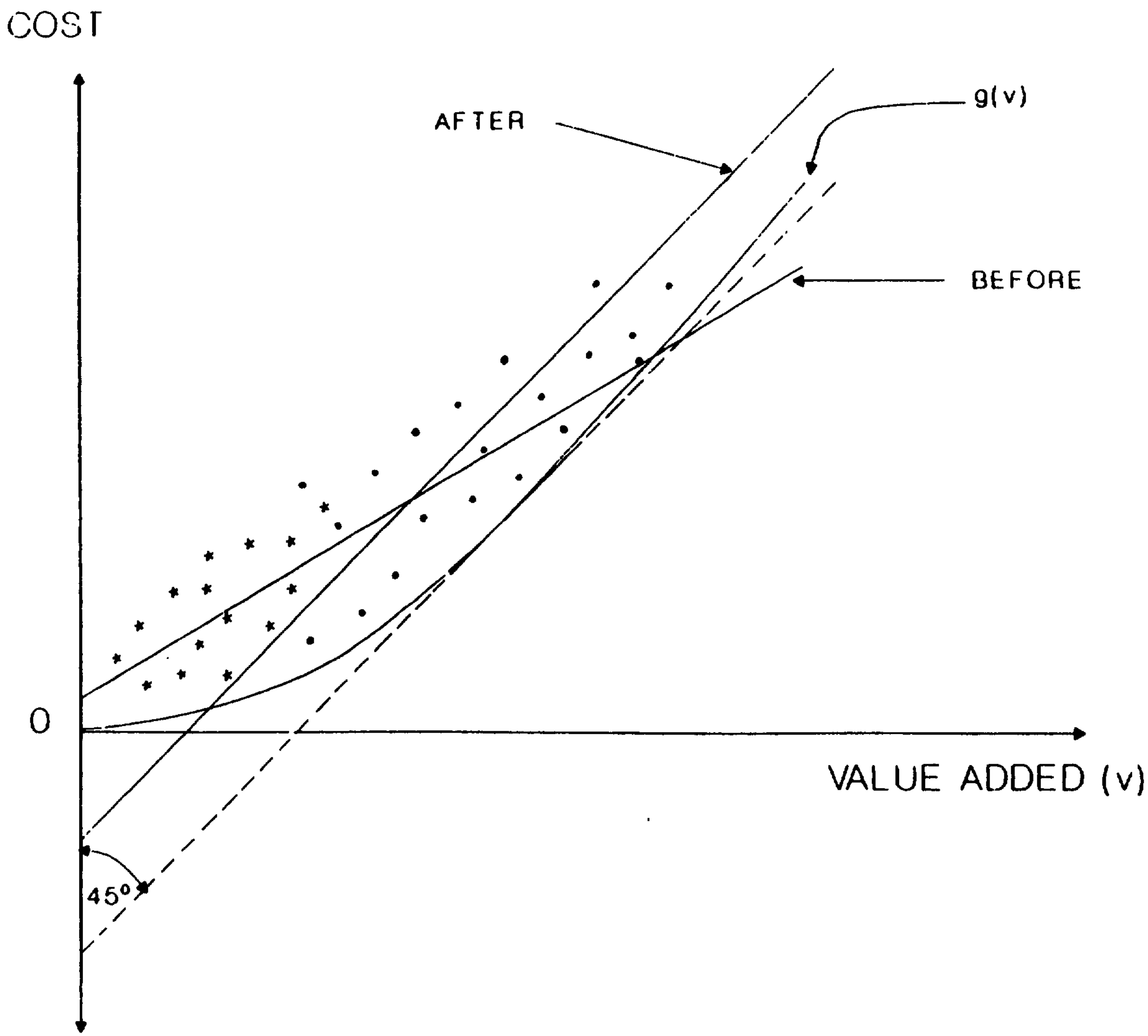
11/ This definition, which began with the work of Farrell (1957), is fairly standard for empirical work. For literature surveys, see Forsund, Lovell and Schmidt (1980) and Schmidt (1985).

FIGURE 1



associated plants are not operating at maximum technical efficiency.[12] Assuming that deviations from the efficient technology are Hicks-neutral, the horizontal distance from the cost function for the i^{th} plant is a monotonic positive function of its technical inefficiency level, e_i.

Suppose that trade liberalization forces some plants in the increasing returns region to expand or exit the market, eliminating the data points represented by asterisks in figure 1. Then Cobb-Douglas estimates of the returns to scale ($\alpha+\beta_1$) are likely to fall, as the "before" and "after" regression lines make clear.[13] The cost function intercept is also likely to fall, or equivalently, the production function intercept (β_0) is likely to rise. Finally, given that the Cobb-Douglas technology implies a log-linear relationship between costs and output, it should fit the data better after plants in the increasing returns range have been eliminated. So the variance in u_1 (σ_1^2) is likely to drop with trade liberalization unless offseting changes in measurement error occur.

12/ With measurement error in value added, some observed data points might fall below the cost function. Measurement error does not alter the analysis unless its variance changes across census years in a way that is correlated with changes in protection rates. We assume this does not occur.

13/ Returns to scale estimates should fall for the estimated production function as well as the estimated cost function, since cost is simply an index of factor usage. Interpreted this way, figure 1 may be viewed as representing the inverse production function.

There is another reason that σ_1^2 may fall and (β_0) may rise as efficiency improves. Imagine that heightened exposure to foreign competition forces all plants to move toward the efficient technology, so that the data points in figure 1 drift to the right, and cluster more closely above the efficient cost function. Then the residual variation and the intercept of the estimated cost function would fall.[14] These effects can occur without any change in the estimated returns to scale, so by examining the changes in β_0, σ_1^2, and $\alpha+\beta_2$ together, we may be able to learn something about the relative importance of scale effects versus technical efficiency effects.

B. Dealing with Imperfect Data

Problems of missing data and measurement error complicate the analysis. As mentioned above, capital stock figures do not accurately reflect true stocks, and for many plants they are missing entirely. We deal with these problems by employing an estimator that combines errors-in-variables techniques developed by Goldberger (1972) with missing data treatments exposited in Gourieroux and Monfort (1981). This estimator provides maximum likelihood estimates for equation (1), given the following relationships (Tybout, 1990):

14/ Much of the micro-econometric literature on efficiency measurement is devoted to capturing these two effects (e.g., Schmidt, 1985). We depart from this literature somewhat because of the data problems discussed in the following subsection.

$$(2) \qquad K^* = \gamma Z + \delta_0 + \delta_1 E + \delta_2 D_1 + \delta_3 D_2 + \delta_4 D_3 + u_2$$

$$(3) \qquad K = K^* + u_3$$

Here K is book value of capital stock, which differs from the true stock by the measurement error u_3, and is missing entirely for a fraction of the sample. Also Z is an instrument for the true capital stock (see the appendix for details). When estimating the system (1) through (3), we assume that all disturbances are independent of one another, and labor and capital are exogenous.[15] Also, we assume that the missing data pattern is "ignorable" (e.g., Little, 1982), and hence does not create selectivity bias.[16]

15/ This exogeneity assumption is justifiable if firms choose input levels before observing current period shocks to technology and to real input prices (e.g., Zellner, Kmenta, and Dreze, 1966). This condition seems to suit 1967 particularly well, given that labor laws were very strict, and labor dismissal was difficult. Nonetheless, we experimented with an alternative version of the model in which it was assumed that firms observe current period wages without error and freely adjust employment levels to maximize short-run profits. This extension yielded implausible results, suggesting the approach taken here is a closer approximation to behavior.

16/ This assumption can be relaxed (Tybout, 1990). However, experiments in which we did so suggested that selectivity bias was minimal, so we opted for the simpler estimator.

C. The Estimated Effect of Trade Reforms on Productive Efficiency

Estimates of the system (1) through (3) for each industry and year are presented and discussed in appendix 1. We use the results to construct industry-specific indices of the changes in returns to scale, average efficiency level (i.e., production function intercept), and dispersion in efficiency levels between 1967 and 1979. For the j^{th} industry (j=1, 21), these measures are:

$$\mathrm{SCALE}_j = \left(\hat{\alpha}_j + \hat{\beta}_{1j} \right)_{79} \Big/ \left(\hat{\alpha}_j + \hat{\beta}_{j1} \right)_{67}$$

$$\mathrm{EFFIC}_j = \left(\hat{\beta}_{0j} \right)_{79} \Big/ \left(\hat{\beta}_{0j} \right)_{67}$$

$$\mathrm{DISPER}_j = \left(\hat{\sigma}^2_{1j} \right)_{79} \Big/ \left(\hat{\sigma}^2_{1j} \right)_{67}$$

Here hats indicate estimated values, and subscripts outside brackets refer to the year of the census from which the estimates were obtained. As with our descriptive statistics of section II.C, these indices are relatively robust with respect to industry-specific distortions in estimators. Such distortions will not matter if they bias estimators by the same factor in each year, or (when comparing across industries) if the factor of bias is common to all industries.

The top panel of Table 3 presents estimated values for each parameter ratio of interest, industry by industry, along with associated PROTEC values. As in table 1, there is still no evidence of <u>overall</u> improvements in productive efficiency for the manufacturing sector. Of the 21 manufacturing industries analyzed, only 10 showed reductions in estimated returns to scale, only 9 showed evidence of Hicks neutral productivity improvements, and only 5 registered reductions in our index of efficiency dispersion.

Recall, however, that many macro shocks hit the Chilean manufacturing sector between the census years, masking the effects of commercial policy in sector-wide analyses. Therefore, to isolate the influence of trade reforms from shocks that are common to all industries, we once again turn to cross-industry comparisons. Spearman rank correlations and t ratios for PROTEC, SCALE, EFFIC, and DISPER are reported in the bottom panel of table 3. Here notice that relatively large reductions in protection are associated with relatively marked declines in the estimated returns to scale. Although this association is statistically weak, it builds on our table 2 findings. There we saw that small plants tend to drop out or grow as protection is removed; here we find evidence that this process generates some efficiency gains.

More strikingly, the intercept of the production function appears strongly negatively associated with the level of protection, as does the dispersion in output levels conditioned on inputs. These correlations are partly due to a flattening of the regression line, as the correlation between SCALE and EFFIC makes clear.[17] However, SCALE does not correlate as strongly with reductions in protection as does EFFIC, so we are tempted to conclude that such reductions are associated with movements toward the efficient technology across a wide range of

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17/ Even when the underlying population remains unchanged, sampling error is likely to induce a negative correlation between the intercept and the sum of the slope coefficients, so we caution against reading too much into the high t ratio for the rank correlation of SCALE and EFFIC.

Table 3: VALUES AND RANK CORRELATIONS OF PROTEC, SCALE, EFFIC and DISPER

Estimated Parameter Ratios

Industry	PROTEC	SCALE	EFFIC	DISPER
food	.24	.97	.97	1.89
beverages	1.47	1.02	1.06	1.46
textiles	.19	1.01	1.14	2.44
apparel	.98	.95	1.02	2.21
leather products	.96	.99	.54	3.10
footwear	1.01	.99	.83	4.10
wood and cork	1.13	1.26	.53	2.86
wood furniture	1.11	1.18	.76	2.10
pulp and paper	.60	1.18	.24	.90
printing	1.31	1.00	.91	3.13
indus. chemicals	.69	.98	.94	1.61
other chemicals	.95	1.17	.81	2.33
rubber products	.28	1.04	3.66	.98
plastic products	.50	.88	1.41	2.06
glass*	.03	.72	1.49	1.19
non-metal minerals	1.13	1.13	.65	3.41
iron and steel	.87	.79	1.14	2.04
metal products	.60	1.08	.85	2.72
non-elec. mach.	.64	.92	1.42	.94
elec. mach.	.20	.90	1.72	.94
transport equip.	.39	1.06	.77	.99

Spearman Rank Correlations**

	SCALE	EFFIC	DISPER
PROTEC	.387 (1.83)	-.523 (-2.68)	.546 (2.85)
SCALE		-.731 (-4.67)	.239 (1.07)
EFFIC			-.461 (-2.26)

* This industry exhibited such an extreme reduction in measured protection that we redid the analysis without it. None of the results (available on request) were significantly affected.

** t ratios are in parentheses

plant sizes. That is, the apparent changes in overall efficiency were probably not exclusively attributable to small inefficient plants expanding or dropping out.

Taken together, the rank corelations in table 3 are wholly consistent with the table 2 finding that industries undergoing the most reduction in protection showed the most productivity improvement. They also appear to confirm the adjustment processes discussed in connection with figure 1. Nonetheless, there are alternative plausible explanations for our findings. Consider the scale result first. Changes in returns to scale are negatively associated with changes in average plant size across the two censuses, as one would expect.[18] So it appears that expansions in plant size do partly account for reductions in estimated returns to scale. But other factors may also be at work. Specifically, our data deflation is based on the presumption that products are homogeneous at the 3-digit level. This is obviously unlikely, and could lead to misinterpretations. That is, when value added is deflated by an industry price deflator, we are not really isolating a physical quantity, even if intermediate inputs are always used in fixed proportion to output. This means that if big firms achieve larger mark-ups because of market power, they will appear to have more output per unit input -- that is, they will appear more scale efficient. Moreover, if reductions in protection force these firms to price competitively, it will appear that returns to scale in the

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18/ The rank correlation between average plant size changes and scale changes is about -.30.

industry have decreased.[19] This is surely a result in favor of trade liberalization, but not the one we have stressed.

Several alternative explanations also come to mind for the technical efficiency findings. For example, the positive correlation between PROTEC and DISPER might have been generated by a reduction in product diversity within certain 3-digit industries, making intra-industry technology more uniform across plants. This, too, would reduce observed deviations from the estimated technology. As for the association between PROTEC and EFFIC, it might reflect a downward shift of the efficient cost function for industries exposed to world competition. If this explains table 3, dispersion about the average isoquant need not have fallen most in the industries with the greatest average efficiency improvement. Given that the rank correlation between DISPER and EFFIC is only -.13 (t=-.55), this interpretation of the results appears to have some merit.

Finally, despite our very encouraging findings, it should be stressed that they reflect a number of somewhat arbitrary decisions regarding data preparation and model specification. First, there was some specification search involved in choosing the capital stock instrument. Initially electricity consumed was used, and when it became clear that this led to very inaccurate estimates, we switched to

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19/ Using the same data, de Melo and Urata (1986) found that price-cost margins decreased slightly between the two census years. They attribute this to increased competitive pressures from liberalization.

machinery and equipment.[20] Second, our protection estimates for 1967 are crude. Third, with respect to specification, it must also be recognized that our crude measure of labor input is probably not strictly exogenous. So if labor usage depends on output demand and some omitted variables -- e.g. the wage-price ratio -- changes in the omitted variable can change the estimated relationship between labor and output. (Changes in the structure of protection alter the cross-sectoral pattern of wage-price ratios, and hence in principle could change the apparent pattern of scale economies.)

About these shortcomings little could be done. However, we did test for robustness by trying alternative variable definitions and model specifications. With respect to data, we experimented with two alternative industry-specific deflators for gross output and found that our results were robust to the selection of industry-specific gross output deflator (results available upon request). We also developed an extension of the model treating labor as endogenous (see footnote 15). Unfortunately, this yielded implausibly low estimates for returns to scale, probably reflecting problems with our wage variable and the imposition of too much structure on the data.[21]

20/ However, tests for the association between protection and efficiency were not performed until we had settled on our instrument, nor did we even compare results from the two census years industry-by-industry. Hence our search in itself did not bias the results in favor of our priors.

21/ Our data do not specify location of establishments, so we are unable to control for the possibility that firms in different localities may face different wage-price ratios.

IV. CONCLUDING REMARKS

This paper provides new micro evidence on the relationship between choice of development strategy and industrial sector performance. Our contribution departs from the existing literature in several respects. First, unlike virtually all other evidence, ours is at the establishment level. Thus we are able to address theories of intra-industry adjustment much more directly than has been possible in the past. Second, there is dramatic variation in the trade regime between our sample years. This gives our analysis a laboratory-like flavor, and creates sufficiently large changes in industrial performance to be detectible despite measurement problems. Finally, unlike much of the literature, our study tracks a single country through time, eliminating the complicating influence of country-specific effects.

Although the findings are suggestive, much more plant-level work must be done before we can be confident of the "stylized facts" regarding intra-industry adjustments to trade reforms. We are currently attempting to generate further evidence by analyzing additional liberalization episodes and by exploiting panel data that follow individual plants through time.

Appendix 1: Production Technology Estimates

This appendix presents more detail on our estimates of equations (1) through (3) of the text.

A. Variable Definitions

The variables we used to estimate these equations are presented in table A1. We call the reader's attention to several details. First, following Maddala (1977) we use a size dummy (D_3) as an instrument for the capital stock. This dummy also appears in the production function (1) because imposing an exclusion restriction would have vastly complicated estimation (Tybout, 1990). Empirically, coefficients on D_3 in equation (1) are all very close to zero, so the only cost of proceeding this way is apparently a small loss of power.

Second, notice that Z, which serves as another instrument for the true capital stock, is defined to be machinery and equipment. This reflects several considerations. One is that machinery and equipment are almost always reported.[22] (When total capital is missing, it is usually because firms have rented their buildings, land, or vehicles.)

22/ This is less true in 1979 than in 1967. Obviously, observations that do not include machinery and equipment must be excluded from the estimation altogether. Details of our data preparation are available upon request.

Table A1: VARIABLE DEFINITIONS FOR SECTION III ESTIMATES

V =	logarithm of value added corrected for inflation distortions and expressed in 1979 prices
E =	logarithm of labor, expressed in efficiency units[23]
D_1 =	1 if the firm is a proprietorship, 0 otherwise
D_2 =	1 if the firm is a partnership, 0 otherwise[24]
D_3 =	-1 if the firm is among the smallest third of the industry sample; 0 if the firm is among the middle third of the industry sample; and 1 if the firm is among the largest third of the industry sample
K =	logarithm of the reported value of the capital stock, i.e., machinery and equipment plus vehicles, plus land and buildings. (This variable is considered "missing" if at least one component takes a zero or missing value.)
Z =	logarithm of machinery and equipment

The other consideration is that the instrument Z should be correlated with true capital, but not with the measurement error u_2. If measurement error

23/ This variable is constructed as the wage bill divided by the minimum wage. The wage bill includes an imputation for owners and family help. See Griliches and Ringstad for a similar definition. In earlier work (Corbo and deMelo, 1985), we tested several specifications of the labor variable to deal with heterogeneity in the labor force and found that labor input measured by the total number of unskilled equivalent workers was the best.

24/ Partnerships could not be distinguished in the 1967 data, so all firms with between 1 and 10 owners were considered partnerships in that year.

in capital is essentially due to the longer term items -- i.e., buildings and land -- machinery and equipment satisfy this condition.[25]

B. **Parameter Estimates**

Table A2 reports estimated output elasticities with respect to capital(α) and labor (β_1), their sum ($\alpha+\beta_1$), the intercept (β_0), and estimates for σ_1^2, σ_2^2 and σ_3^2. To give some sense for the overall fit, we include total variation in V (σ_V^2) for comparison with σ_1^2. Numbers in parentheses are asymtotic "z" ratios for the null hypothesis that the coefficient estimated immediately above is zero <u>except</u> in the case of returns to scale, where the null is that returns to scale are unity. Finally, the number of observations used for each industry (n) and the number for which capital stocks are observable (n_c) are also reported.

Observe first that the scale estimates are generally very plausible, although the labor coefficient is sometimes larger than one would expect. We found that although the scale estimate $\alpha+\beta_1$ was insensitive to the instrument (Z) used, choice of instrument did affect the breakdown of returns to scale between α and β_1. So, although the scale estimates seem robust, these individual magnitudes should be viewed with some caution.

Note next that the estimated variances of u_1 are always significantly positive, while those of u_2 and u_3 sometimes are not.

<u>25</u>/ We also tried electricity consumption as an instrument for capital but found it had low predictive power. (It was also unattractive conceptually because electricity is subject to relatively severe endogeneity problems.) Installed horsepower was an alternative to machinery and equipment, but this variable was only available in the 1967 census.

Table A2: INDUSTRY-WIDE PRODUCTION TECHNOLOGIES 1967 VS. 1979

INDUSTRY/DESCRIPTION	YEAR	n/nc	INTERCEPT β_0	CAPITAL α	LABOR β_1	σ^2_1	σ^2_2	σ^2_3	σ^2_v	RETURNS TO SCALE $\alpha + \beta_1$
312 FOOD PRODUCTS	67	1543/ 801	2.802 (15.48)	0.345 (11.89)	0.645 (16.36)	0.428 (23.36)	0.200 (5.09)	0.060 (1.62)	2.26	0.990 (-0.35)
	79	1880/ 698	2.720 (15.12)	0.329 (11.77)	0.632 (15.03)	0.808 (28.96)	0.124 (2.41)	0.104 (2.03)	2.90	0.961 (-1.27)
313 BEVERAGES	67	429/ 122	2.383 (3.98)	0.389 (5.10)	0.682 (9.64)	0.806 (12.56)	0.248 (2.39)	-0.048 (-0.49)	2.57	1.071 (1.00)
	79	138/ 74	2.521 (2.66)	0.315 (2.66)	0.783 (4.37)	1.179 (8.17)	0.049 (0.26)	0.166 (0.87)	4.18	1.098 (0.69)
321 TEXTILES	67	666/ 271	3.191 (11.40)	0.332 (7.75)	0.611 (12.64)	0.318 (17.90)	-0.025 (-0.60)	0.197 (4.36)	2.23	0.943 (-1.69)
	79	657/ 216	3.635 (12.39)	0.133 (3.23)	0.819 (12.22)	0.775 (17.74)	0.329 (2.16)	-0.218 (-1.45)	3.17	0.953 (-0.91)
322 WEARING APPAREL	67	582/ 104	2.569 (4.12)	0.504 (5.13)	0.613 (7.28)	0.413 (15.59)	-0.075 (-1.49)	0.284 (4.55)	1.94	1.118 (1.77)
	79	621/ 149	2.610 (6.36)	0.268 (4.04)	0.791 (9.30)	0.912 (15.47)	0.453 (3.16)	-0.243 (-1.80)	2.74	1.059 (0.93)
323 LEATHER PRODUCTS	67	128/ 56	4.693 (6.57)	0.163 (1.43)	0.698 (6.45)	0.245 (8.01)	-0.099 (-0.54)	0.316 (1.64)	2.06	0.861 (-1.71)
	79	109/ 49	2.531 (3.47)	0.483 (4.19)	0.364 (1.89)	0.760 (7.49)	-0.070 (-0.72)	0.200 (1.89)	2.86	0.847 (-1.08)
324 FOOTWEAR	67	323/ 81	3.385 (9.22)	0.260 (3.72)	0.738 (9.57)	0.297 (11.02)	0.147 (1.16)	0.104 (0.84)	2.14	0.998 (-0.05)
	79	2661/ 57	2.826 (4.09)	0.200 (1.78)	0.794 (5.44)	1.219 (11.25)	0.221 (0.74)	-0.061 (-0.21)	3.34	0.994 (-0.06)
331 SAWMILLS, WOOD & CORK	67	732/ 266	5.143 (18.46)	0.206 (4.62)	0.636 (12.20)	0.389 (17.88)	0.160 (1.50)	0.148 (1.38)	1.71	0.842 (-4.11)
	79	502/ 196	2.737 (6.04)	0.210 (2.90)	0.847 (8.18)	1.116 (15.25)	0.278 (1.26)	0.083 (0.38)	3.34	1.058 (0.79)
332 WOOD FURNITURE	67	416/ 108	4.041 (12.80)	0.194 (3.24)	0.714 (9.49)	0.375 (11.44)	0.539 (2.58)	-0.161 (-0.83)	1.64	0.908 (-1.78)
	79	368/ 93	3.063 (6.99)	0.162 (2.22)	0.908 (8.77)	0.789 (12.41)	0.651 (1.67)	-0.222 (-0.59)	2.45	1.070 (0.90)
341 PULP AND PAPER	67	39/ 24	3.997 (4.46)	0.303 (2.36)	0.579 (3.38)	0.308 (3.88)	0.151 (0.77)	0.065 (0.35)	3.77	0.882 (-1.04)
	79	68/ 29	0.978 (1.36)	0.623 (5.08)	0.417 (2.34)	0.277 (1.25)	0.372 (0.96)	-0.017 (-0.14)	4.95	1.040 (0.39)
342 PRINTING	67	302/ 76	3.928 (11.87)	0.413 (7 62)	0.530 (7.27)	0.207 (8.59)	0.110 (1.57)	0.091 (1.38)	1.97	0.943 (-1.12)
	79	388/ 106	3 555 (11.85)	0.183 (3.94)	0.755 (10.34)	0.649 (13.47)	0.240 (1.65)	-0.129 (-0.90)	2.43	0.938 (-1.13)
351 CHEMICALS (INDUSTRIAL)	67	81/ 45	4.578 (5.47)	0.227 (2.21)	0.642 (4.44)	0.507 (6.65)	-0.348 (-2.17)	0.487 (2.79)	2.55	0.869 (-1.12)
	79	51/ 24	4.303 (4.10)	0.309 (2.58)	0.542 (2.32)	0.817 (4.71)	0.247 (1.24)	-0.150 (-0.79)	3.00	0.851 (-0.81)
352 OTHER CHEMICALS	67	206/ 109	3.841 (5.95)	0.478 (4.98)	0.335 (3.30)	0.352 (8.44)	0.074 (1.10)	0.178 (2.55)	2.35	0.813 (-2.54)
	79	188/ 112	3.120 (4.84)	0.343 (4.10)	0.606 (4.71)	0.820 (8.55)	0.321 (2.45)	-0.105 (-0.86)	4.30	0.948 (-0.51)
355 RUBBER PRODUCTS	67	61/ 31	0.925 (0.52)	0.784 (2.82)	0.176 (0.59)	0.564 (5.51)	-0.175 (-2.48)	0.586 (4.22)	3.15	0.960 (-0.22)
	79	83/ 39	3.128 (4.04)	0.240 (1.79)	0.761 (4.14)	0.552 (6.64)	-0.336 (-1.82)	0.501 (2.49)	3.32	1.001 (0.01)
356 PLASTIC PRODUCTS	67	100/ 39	3.122 (4.47)	0.257 (3 16)	0.817 (6.98)	0 291 (7.39)	-0.229 (-1.54)	0.486 (2.79)	2.16	1.074 (0.70)
	79	185/ 64	4.398 (6.38)	0.025 (0.24)	0 914 (7 06)	0 601 (9.59)	-1 167 (-0.49)	1.537 (0.64)	2.34	0.938 (-0.69)

Table A2: INDUSTRY-WIDE PRODUCTION TECHNOLOGIES 1967 VS. 1979 (continued)

INDUSTRY/DESCRIPTION	YEAR	n/nc	INTERCEPT β_0	CAPITAL α	LABOR β_1	σ^2_1	σ^2_2	σ^2_3	σ^2_v	RETURNS TO SCALE $\alpha + \beta_1$
362 GLASS	67	51/ 27	2.726 (2.18)	0.357 (1.84)	0.703 (3.35)	0.489 (4.69)	0.085 (0.48)	0.113 (0.64)	3.67	1.060 (0.38)
	79	37/ 17	4.072 (2.80)	0.349 (1.66)	0.416 (1.62)	0.585 (4..4)	0.048 (0.14)	0.330 (0.93)	3.91	0.764 (-1.26)
369 NON-METALLIC MINERAL PRODUCTS	67	146/ 67	3.105 (7.29)	0.305 (4.55)	0.708 (6.82)	0.261 (6.16)	0.284 (1.70)	0.119 (0.79)	2.17	1.013 (0.18)
	79	152/ 43	2.024 (3.57)	0.243 (2.57)	0.898 (5.87)	0.891 (8.65)	-0.049 (-0.17)	0.294 (0.99)	4.41	1.142 (1.40)
371 IRON AND STEEL	67	52/ 28	2.624 (2.84)	0.449 (4.71)	0.619 (4.66)	0.301 (4.73)	0.030 (0.37)	0.081 (0.98)	2.82	1.068 (0.52)
	79	41/ 18	2.997 (2.49)	0.463 (2.58)	0.387 (1.60)	0.613 (3.14)	0.363 (1.35)	-0.122 (-0.57)	4.26	0.850 (-0.89)
381 METAL PRODUCTS	67	636/ 238	4.136 (15.98)	0.206 (5.12)	0.702 (14.85)	0.290 (13.93)	0.467 (4.59)	-0.207 (-2.31)	2.33	0.908 (-2.63)
	79	625/ 224	3.505 (10.40)	0.124 (2.49)	0.866 (12.76)	0.789 (17.40)	0.266 (1.27)	-0.077 (-0.37)	3.23	0.991 (-0.18)
382 NON-ELECTRICAL MACHINERY	67	289/ 99	2.705 (4.35)	0.063 (0.71)	0.905 (7.94)	0.903 (12.03)	-0.249 (-0.34)	0.484 (0.66)	3.20	0.967 (-0.36)
	79	173/ 71	3.848 (5.62)	0.259 (3.02)	0.633 (4.65)	0.848 (9.31)	-0.043 (-0.30)	0.156 (1.09)	2.89	0.893 (-0.90)
383 ELECTRICAL MACHINERY	67	95/ 45	2.183 (2.45)	0.287 (2.46)	0.826 (5.14)	0.717 (6.60)	0.135 (0.77)	0.013 (0.07)	3.61	1.113 (0.81)
	79	76/ 48	3.746 (3.79)	0.066 (0.45)	0.934 (4.57)	0.673 (5.83)	1.576 (2.19)	-1.429 (-2.03)	3.39	1.000 (-0.00)
384 TRANSPORT EQUIPMENT	67	184/ 76	4.403 (7.45)	0.266 (3.40)	0.717 (6.91)	0.623 (9.52)	-0.012 (-0.09)	0.159 (1.20)	3.00	0.983 (-0.20)
	79	164/ 65	3.376 (6.40)	0.115 (1.75)	0.927 (8.25)	0.616 (8.91)	0.257 (0.60)	-0.012 (-0.03)	2.75	1.041 (0.45)

However, for these latter two disturbances, only 3 out of 84 estimated variances are significantly negative at the 95 percent level.[26] This gives us some degree of confidence that our model is reasonably specified, and we take these variance estimates to shed some light on the importance of capital stock measurement error. In particular, we observe that all but six sectors showed reductions in the amount of measurement error from 1967 to 1979, perhaps reflecting the fact that firms were instructed to adjust their book values to market worth in the latter year.[27]

26/ Negative variance estiamtes could in principle be eliminated by restricting the parameter space when we maximize the likelihood function, but this would vastly complicate the calculations. (See Tybout (1990) for details.) Given that the variances of u_2 and u_3 are nusiance parameters with little bearing on our analysis, we do not grapple with this problem.

27/ This one-time revaluation was termed the "Retacacion Tecnica", or "technical adjustment".

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Appendix 2: Data Preparation Procedures

This document describes the data preparation steps in the order in which they were done. The preparation began with corrections for inflation bias. Next we excluded some industries that appeared too heterogeneous from a technological point of view and grouped the census establishment-level data according to the 3-digit ISIC classification. Finally we applied some exclusion criteria for errors in data recording. The appendix closes with a discussion of how ERP estimates were obtained for each census year.

1. Correction for Inflation Bias

Two corrections for inflation bias were performed: within census years and between census years. Within census years, we first brought all establishments accounts to the same closing dates to remove biases due to inflation (about 60% in each census year). This was a relatively involved process for value-added, because firms construct the value of their output as final inventories plus sales, minus initial inventories. So when inflation causes the value of inventories to grow over the course of the year, the value of production is overstated (e.g., Tybout, 1988). We undid this bias by stating initial and final inventories in mid-year prices, then reconstructing the value of output using the corrected inventory figures.[27]

Finally, we deleted establishments whose accounts covered less than 12 months, thereby losing 2% of the observations in 1967 and less than 1% for 1979.

27/ For this exercise we assumed that firms all use the "weighted average" inventory valuation convention. This assumption was supported by conversations with Chilean accountants.

Second, we brought the 1967 census data to 1979 prices. We carried out a single-deflation procedure for value-added relying on gross output deflators at the 3 digit ISIC level, which we applied to intermediate inputs using weights from the 1977 input-output table. Value added in 1979 prices was thus obtained as the difference between deflated gross output and deflated intermediate inputs. For capital stocks, we deflated the different components of the capital stock using the respective flow prices in the national accounts.

When used by Mierau (1986) for a study of TEP growth for the Chilean manufacturing sector at a level of disaggregation similar to ours, the wholesale price deflators published by INE often yielded relatively high variations in sectoral gross output growth rates. As an alternative Mierau used physical production indexes which were available for 17 industries and found them to exhibit less extreme variations. Where available, we used these indexes to construct our own deflator which was then applied to the census data. As a third alternative, we constructed a price index based on the US manufacturing wholesale price index using the tariff structure of 1975 (when QRs were removed) to convert the wholesale price index into tariff (and premium) inclusive domestic prices for 1967, and 1979 tariff levels for 1979. This third index assumes purchasing power parity. We carried out all econometric estimation using each one of these three deflators.

In general, the results on the returns to scale estimation were quite robust to the choice of deflator, a reassuring result. Table D1 reports the Spearman rank correlation coefficients for each one of the three deflators. As can be seen the correlation patterns for DEF2 and DEF3 are very close to those for DEF1 which are reported in the main text. The

Table D1: Spearman Bank Correlations with Alternative Deflators

	Deflators a/	DEF1	DEF2	DEF3
Correlations	Glass b/			
Protec, Scale	(w)	0.39 (1.86)	0.35 (1.61)	-0.31 (-1.41)
	(w/o)	0.30 (1.32)	0.24 (1.06)	-0.28 (-1.22)
Protec, Efficiency	(w)	-0.51 (-2.61)	-0.50 (-2.52)	-0.48 (-2.39)
	(w/o)	-0.45 (-2.11)	-0.43 (-2.00)	-0.43 (-2.00)
Protec, Dispersion	(w)	0.54 (2.79)	0.44 (2.16)	0.58 (3.08)
	(w/o)	0.51 (2.50)	0.38 (1.75)	0.53 (2.65)

a/ DEF1 = INE deflator (used in main body of paper).
DEF2 = Deflator built from quantum index. (See text).
DEF3 = Purchasing Power Parity Index. (See text).

b/ Correlations refer to with (w) and without (w/o) the glass industry.

only exception is the correlation between protection and scale which changes sign with DEF3. This is not surprising in view of the way in which DEF3 was constructed (use of 1975 tariffs for 1967 to get premia estimates) and the assumption of purchasing power parity.

2. Exclusion of Industries and Aggregation Scheme

First we excluded from our sample sectors which appeared too heterogeneous from a technology viewpoint (e.g. most industries falling under the category n.e.c. "not elsewhere classified") and sectors which could not be compared across both censuses. The excluded industries appear in Table D2. We then aggregated the remaining sectors into 21 groups according to the aggregation scheme described in Appendix Table D3. The aggregation criteria were: (1) aggregated industries must display a similar technology; (2) aggregated industries must belong to the same sectoral trade orientation (i.e. non-tradables, import-competing or exportables).

The first column of Table D3 gives the code used for our aggregated industry classification referred to as a group. The next two columns give the number of observations remaining after aggregation and prior to the application of exclusion tests described below. The name of the aggregated sectors and their number of observations appear on the right hand side columns. Abbreviations used in the text and in subsequent appendix tables are in parentheses.

3. Exclusion Criteria for Errors in Data Recording

When working with census data, it is necessary to check the data for errors in data recording. This included applying the first seven exclusion criteria in table D4. For example, we eliminated establishments which had a non-positive wage bill (restriction R3 in Table D4). Likewise, we eliminated establishments with less than five workers since the census is for all establishments with five workers or more. Restriction R1 is to exclude establishments that operate seasonally.

Next, following Griliches and Ringstad (1971), we excluded firms with capital/labor and material/labor ratios that were less than 5% of the (weighted) industry average (R8). We checked the characteristics of

Table D2: EXCLUDED INDUSTRIES

ISI 3 digit	Name of Industry	No. of establishments 1967	1979	ISIC (4 digits)	
314	Tobacco industries	4	5	3140	Tobacco industries
353	Petroleum refineries	11	11	3530	Petroleum refineries
354	Misc. products of petroleum and coal	6	13	3540	Misc. products of petroleum and coal
361	Pottery, china and earthenware	20	18	3610	Pottery, china and earthenware
372	Non-ferrous Metals	10	47	3721	Copper
				3729	Non-ferrous basic industries
385	Professional Equipment and Optical Goods	35	22	3851	Professional Equipment
				3852	Optical goods
390	Other manufacturing industries	211	120	3901	Jewelry
				3902	Musical instruments
				3903	Sporting and athletic goods
				3909	Manufacturing indus.

Table D3: AGGREGATION TO 3 DIGIT ISIC

ISIC 3 digit	No. of establishments[1] 1967	1979	Name of Industry	ISIC at 4 digits	
312	2233	2750	Food Products	3111	meats
				3112	dairy
				3113	fruits
				3114	fish
				3115	oils
				3116	grain
				3117	bakery
				3118	sugar
				3119	confectionary
				3121	food n.e.c.
				3122	animal food
313	1012	361	Beverages	3131	distillery
				3132	wine
				3133	malt liquors
				3134	non-alcoholic bev.
321	789	821	Textiles	3211	spun fabrics
				3212	textile goods
				3213	knitting mills
				3214	rugs & carpets
				3215	cordage
				3219	textiles n.e.c.
322	678	794	Wearing Apparel	3220	wearing apparel
323	167	150	Leather Products	3232	tanneries and leather finishing

1/ Before deleting observations.

Table D3: AGGREGATION TO 3 DIGIT ISIC (cont'd)

ISIC 3 digit	No. of establishments[1] 1967	1979	Name of Industry	ISIC at 4 digits	
324	342	353	Footwear	3240	footwear
331	1521	862	Sawmills, Wood and Cork	3311	sawmills
				3312	wood
				3319	wood and cord prod. n.e.c.
332	469	540	Wood Furniture	3320	wood furniture
341	86	98	Pulp and Paper	3411	pulp and paper
				3412	paper bags and carton boxes
				3419	pulp, paper n.e.c.
342	379	480	Printing	3420	printing, pub.
351	102	83	Chemicals (industrial)	3511	basic inorganic chemicals
				3512	fertilizers
				3513	synthetic resins, plastics
				3514	basic, ind. organic chemicals
				3521	paints
352	238	229	Other Chemicals	3522	drugs and medicine
				3523	soaps
				3539	chemicals, n.e.c.

1/ Before deleting observations.

Table D3: AGGREGATION TO 3 DIGIT ISIC (cont'd)

ISIC 3 digit	No. of establishments[1] 1967	1979	Name of Industry	ISIC at 4 digits	
355	77	98	Rubber Products	3551	tires
				3559	rubber products
356	117	230	Plastic Products	3560	plastic products
362	60	50	Glass	3620	glass
369	243	291	Non-metallic Mineral Products	3691	structural clay products
				3693	cement products
				3696	yeso
				3699	non-met. n.e.c.
371	60	80	Iron and Steel	3710	iron and steel
381	730	789	Metal Products	3811	cutlery
				3812	furniture
				3813	structural metal products
				3814	metal containers
				3815	cable, wire
				3819	metal prod. n.e.c.

1/ Before deleting observations.

Table D3: AGGREGATION TO 3 DIGIT ISIC (cont'd)

ISIC 3 digit	No. of establishments[1] 1967	1979	Name of Industry	ISIC at 4 digits	
382	347	246	Non-electrical Machinery	3822	agricultural machinery
				3823	metal machinery
				3824	special ind. mach.
				3825	office machinery
				3829	machinery n.e.c.
383	112	101	Electrical Machinery	3831	elec. ind. mach.
				3832	radio, t.v.
				3833	electrical appliances
				3839	elect. apparatus n.e.c.
384	212	213	Transport Equipment	3841	ships
				3842	railroad equip.
				3843	motor vehicles
				3844	motorcycle
				3845	repairing of aircraft
				3849	transp. n.e.c.
Total Observations	9974	9622			
21 groups					

1/ Before deleting observations

Table D4: EXCLUSION CRITERIA AND NUMBER OF OBSERVATIONS EXCLUDED

	Name of Variable Restriction	Exclusion Criteria	Observations Excluded Year 1967	Observations Excluded Year 1979
R1	Number of days worked by the establishment (ND)	ND < 40	565	18
R2	Total employment (L)	L < 5	1207	0
R3	Blue collar wages and fringe benefits (WL^N_1)	$WL1^N \leq 0$	1	99
R4	Gross value added (VA)	VA < 0	26	260
R5	Gross value of Production (x)	x < 0	1	7
R6	Gross value of Production Less than Value Added	x < VA	3	4
R7	For 1967 only -- Negative Value Added in 1979 Prices		7	
R8	$KST/L \leq .05 \dfrac{\Sigma KST}{\Sigma L}$ and	$M/L \leq .05 \dfrac{\Sigma M}{\Sigma L}$	1351	367
R9	machinery and equipment missing or less than 10,000 pesos	KM < 10,000	16	1457
R10	Incomplete fiscal year		188	654
Total number of exclusions			3625	2866
Total number of observations excluded			2914	2851
Total number of observations included in the sample			7060	6771

establishments failing this test and found many of them employed less than ten workers. (Accordingly, it was a much more important exclusion in the 1967 census.) This exclusion criterion thus aims at purging establishments which are likely to have a different technology because they are primarily engaged in repair activities.

Finally, in a third pass, we excluded establishments which reported a value for machinery and equipment less than 10,000 pesos, or roughly $2,500 (Restriction R9). This arbitrary cut-off point was chosen because many establishments reported a value of 1 for 1979, obviously an error in reporting. The bulk of observations lost were in 1979. A possible explanation is that those establishments rented their equipment.

Table D4 shows the number of observations lost by the application of each criterion and the number of observations lost by the application of each criterion and the distribution of exclusions across criteria. For 1967, the bulk of exclusions concentrated in R1 and R2 came from the food (312), drinks (313) and wood (331) industries. In 1979, the observations were lost because of negative value-added (R4) and missing machinery and equipment. The pattern across industries was fairly even, though somewhat more concentrated in industries 312-332 (due to the greater number of establishments in that group). It is likely that negative value-added reflects ongoing adjustment to the trade reforms.

4. Estimates of Protection

For 1967, implicit tariffs for 92 products were gathered by de la Cuadra through interviews. Since these are based on price comparisons, the effects of QRs are included in these estimates which include at least one representative item from each two-digit SITC division. These estimates are reported in Behrman (1976, table A3). In turn, Behrman took an unweighted arithmetic average of the items in his Table A3 to produce EPR estimates at the subsector level (Behrman, table 5.3, pp. 138-9). Whenever possible, we applied these rates to our aggregation scheme. The following sectors were not covered by Behrman (table 5.3): Wearing Apparel (322); Footwear (324); Industrial Chemicals (351); Other Chemicals (352); Plastics (356). For those sectors we reverted to the disaggregated data in Behrman (table A4) taking again an unweighted arithmetic average of protection rates. This still left us with problems for industries 351, 352, and 356. For 356 we aggregated the price comparisons on chemical products in Behrman Table A4.

There are many shortcomings with the procedures used. To start with, the price comparisons are only for a small sample of products. However, given the prevalence of non-tariff barriers to trade in Chile in 1967, this selection of protection estimates is superior to the alternative based on nominal tariffs from customs data to which we would have had to apply a 1962 input-output matrix to obtain ERPs. Second, biases of unknown magnitude are introduced by using unweighted averages.

For 1979, we relied on the estimates in Aedo and Lagos (1984). For sectors for which no protection estimates were available from Aedo and Lagos we computed ERPs by using nominal protection rates assuming that each sector paid the economy wide average ERP for all intermediates. Since there were no NTBs in 1979 and tariffs were very uniform, it is likely that our measures of ERPs are relatively accurate.

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